

# State of Maryland Perspectives on Cooling Water Intake Technologies to Protect Aquatic Organisms

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Aquatic Organisms from Cooling Water  
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# What is the Power Plant Research Program (PPRP)?

- Created by state legislation in 1971
- Funded by an environmental surcharge on electricity use
- Small technical/administrative staff supported by integrator contractors



# What does PPRP do?

- Provides technical support to Maryland Public Service Commission with regard to licensing of new projects, including NPDES permitting and 316b compliance
- Provides technical support to Department of Environment, Maryland's permitting agency, for renewal of power plant NPDES permits and demonstrations and 316b compliance
- Conducts research relating to major impact issues of proposed and existing power plants



# How does PPRP perform its functions?

- As a result of review of applications, may recommend CWIS studies by applicant
- Conducts technical reviews of applicants= study plans and study results
- Develops cooperative CWIS studies with applicants
- May conduct independent CWIS studies
- Since inception of the program, have carried out such activities at all power plants in Maryland with regard to cooling water intake impacts and structures



# Maryland View of CWIS Technologies and Impacts to Aquatic Biota

- CWIS "hardware" is only one factor in biological impacts
- Mode of operation of some CWIS and how impinged fish are handled are also major factors
- CWIS impacts must be viewed holistically, with the objective of minimizing losses of impinged and entrained organisms

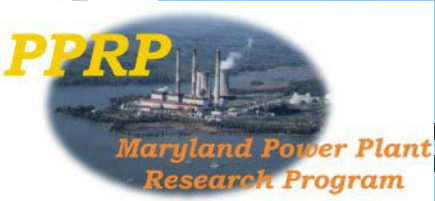
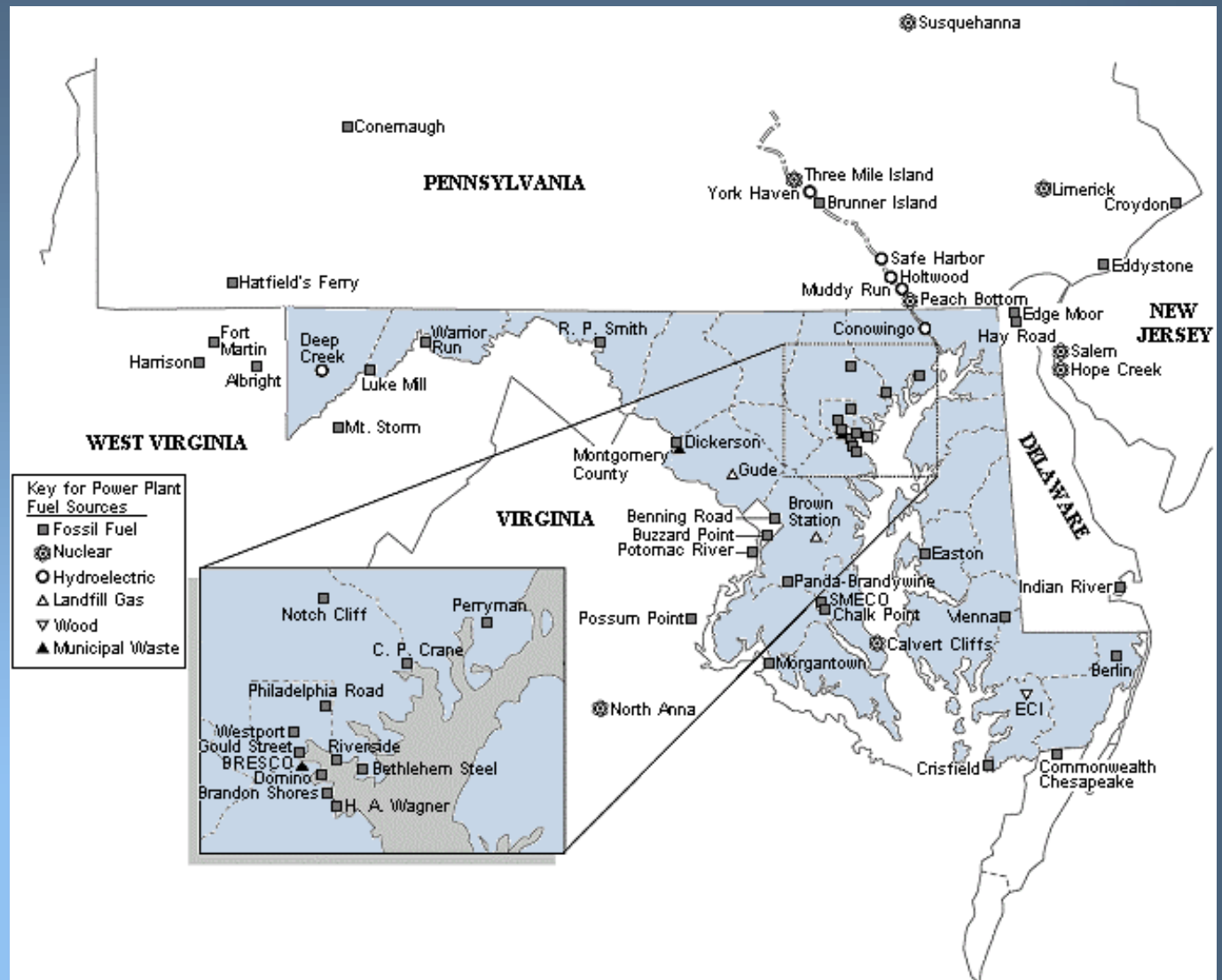


# Overview of Maryland's Application of this View

- Presentation of types of studies done and actions taken to reduce CWIS impacts throughout Maryland over the past 30 years
- Provide examples to illustrate how the evolution of diverse actions taken at various power plants have resulted in significant CWIS impact reductions or resource enhancement



# Locations of power plants in Maryland



# Chalk Point Power Plant

- Owned by Mirant Energy (formerly PEPCO)
- Located on the estuarine portion of the Patuxent River in Prince George's County
- 2,415 MW (total generation)
- Units 1 & 2, once-thru system, 250,000 gal/min per unit; units 3 & 4, closed cycle cooling tower, 260,000 gal/min per unit
- Has both intake and discharge canals



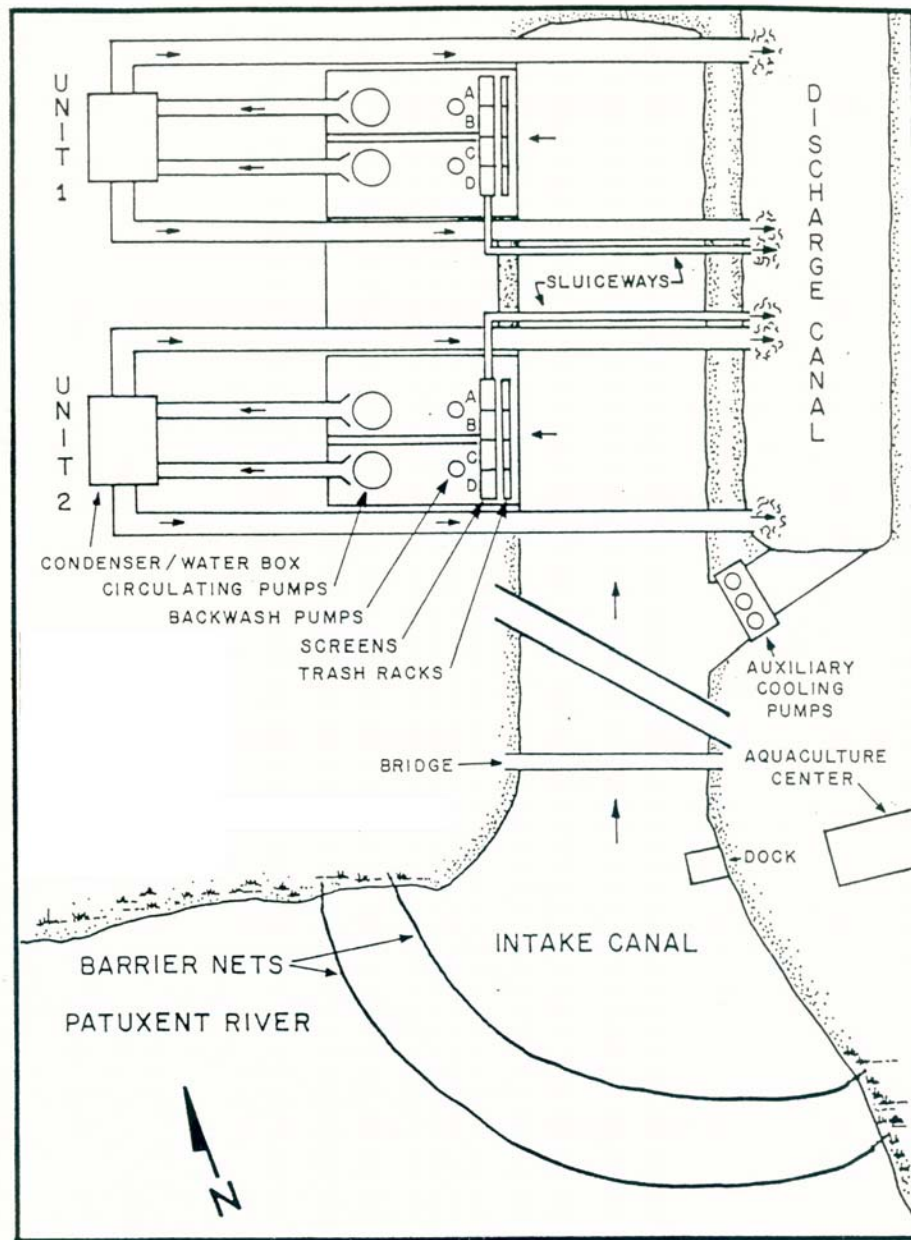




# CWIS Impact Issues at Chalk Point Addressed by PPRP

- Effects of tempering pumps
- Significant impingement of fish and crabs
- Significant entrainment, particularly of bay anchovy





**PPRP**

Maryland Power Plant  
Research Program

# Chalk Point Tempering Pumps

- Included in original plant design to manage delta T in discharge canal
- Shunt water from intake canal directly to discharge canal
- No screening
- Fish concentrated in intake canal
- High mortality of entrained fish and crabs (including early life stages, juveniles and adults) from mechanical injury



# Tempering Pump Issue Resolution

- Quantified and contrasted losses of organisms from thermal stress and entrainment
- Determined that cessation of operation of pumps would result in 50% decline in losses of fish and crabs
- Permit was modified to eliminate the requirement for augmenting discharge flow

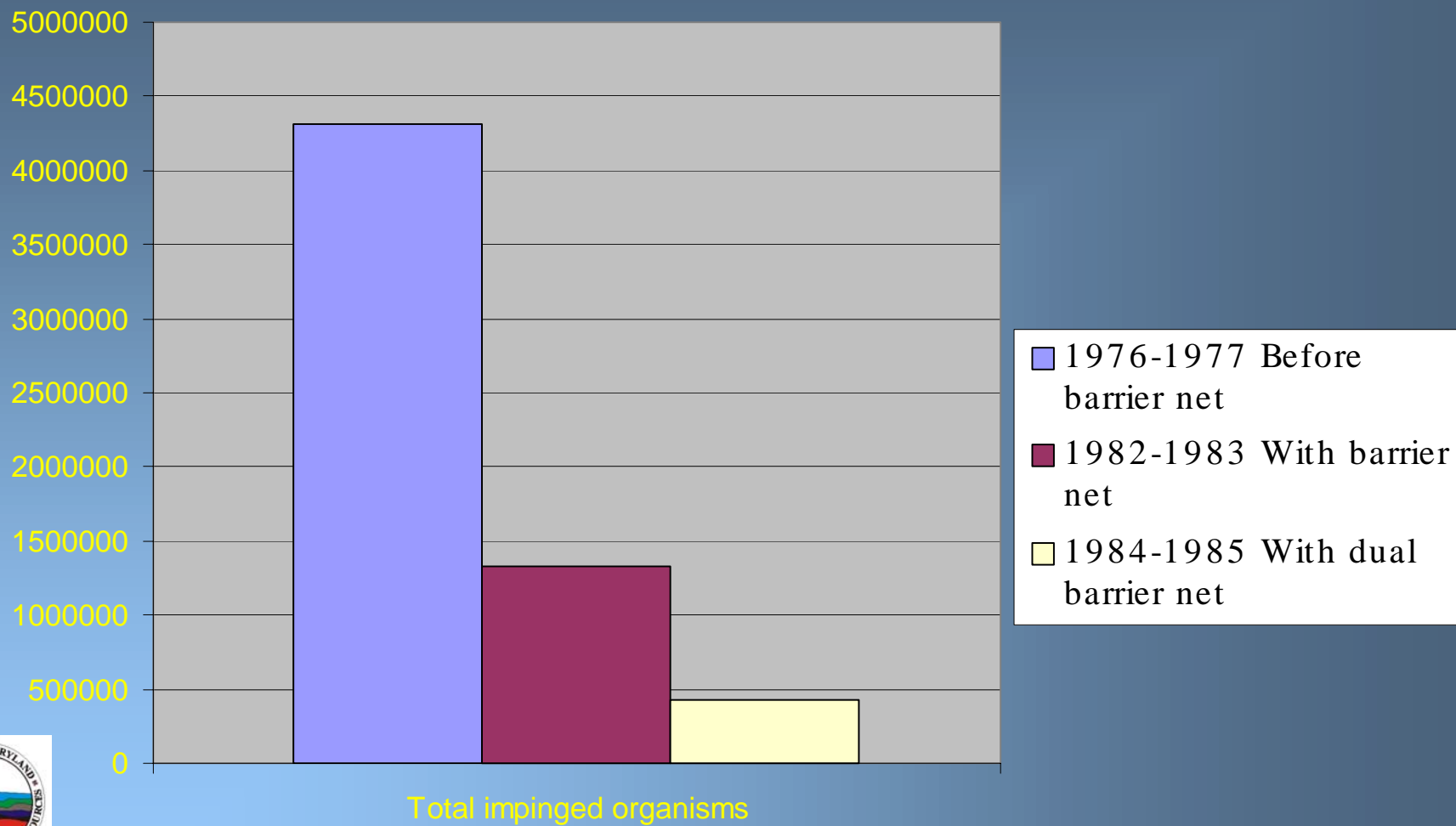


# Impingement Issue Resolution

- Annual impingement averaged about 2 million fish and 2 million crabs before any action
- Plant installed a single barrier net but substantial escapement of smaller fish and crabs through the net
- Negotiated installation of a second (double) barrier net
- About a 90% overall reduction in impingement







# Entrainment Issues

- PPRP estimated entrainment loss as high as 76 % of bay anchovy stock (disputed by PEPCO)
- Considered alternative CWIS, including wedge-wire screens, cooling towers and outages
- Because of lack of information on wedge-wire screen efficacy in estuarine waters, PPRP implemented feasibility studies at Chalk Point in cooperation with PEPCO





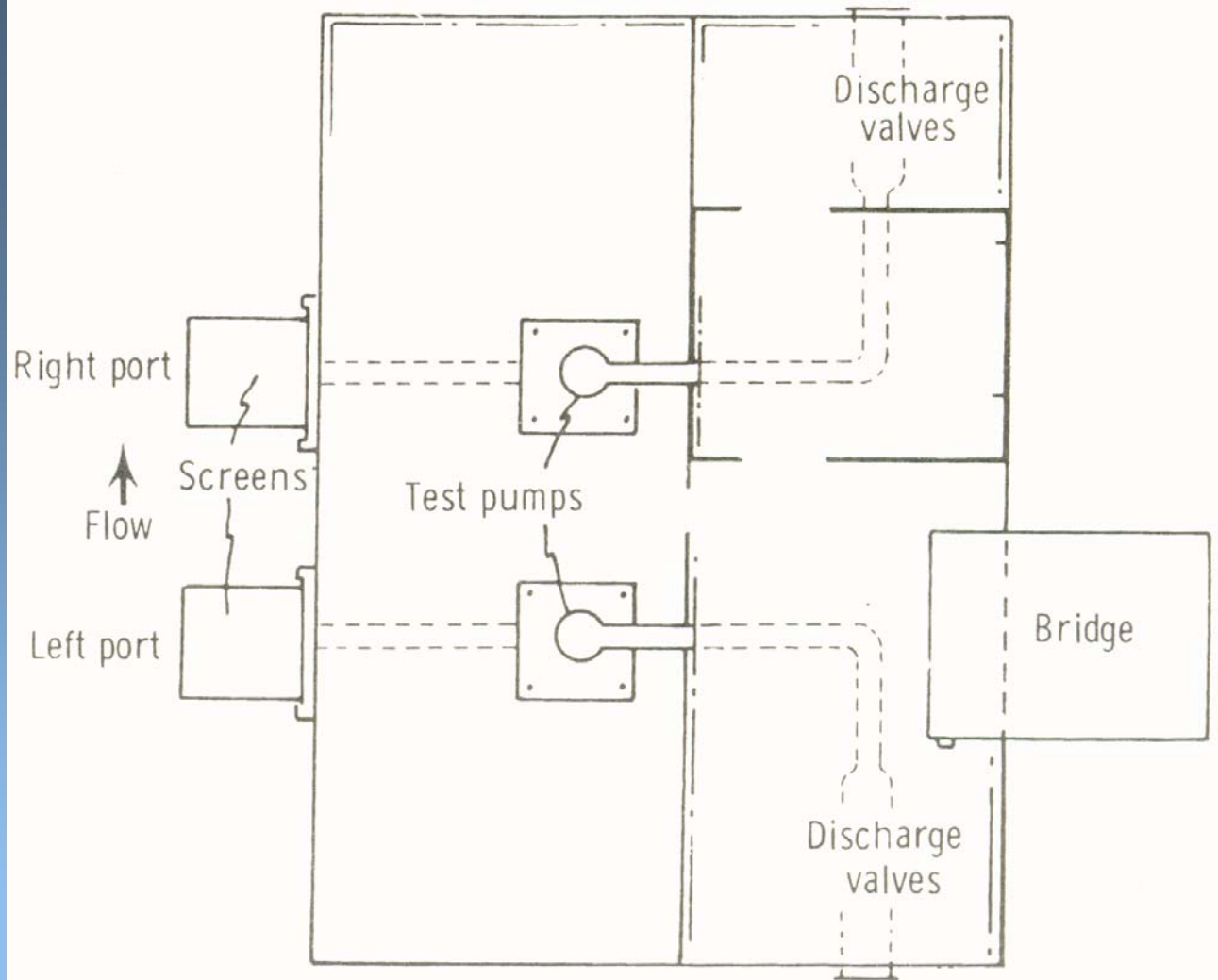
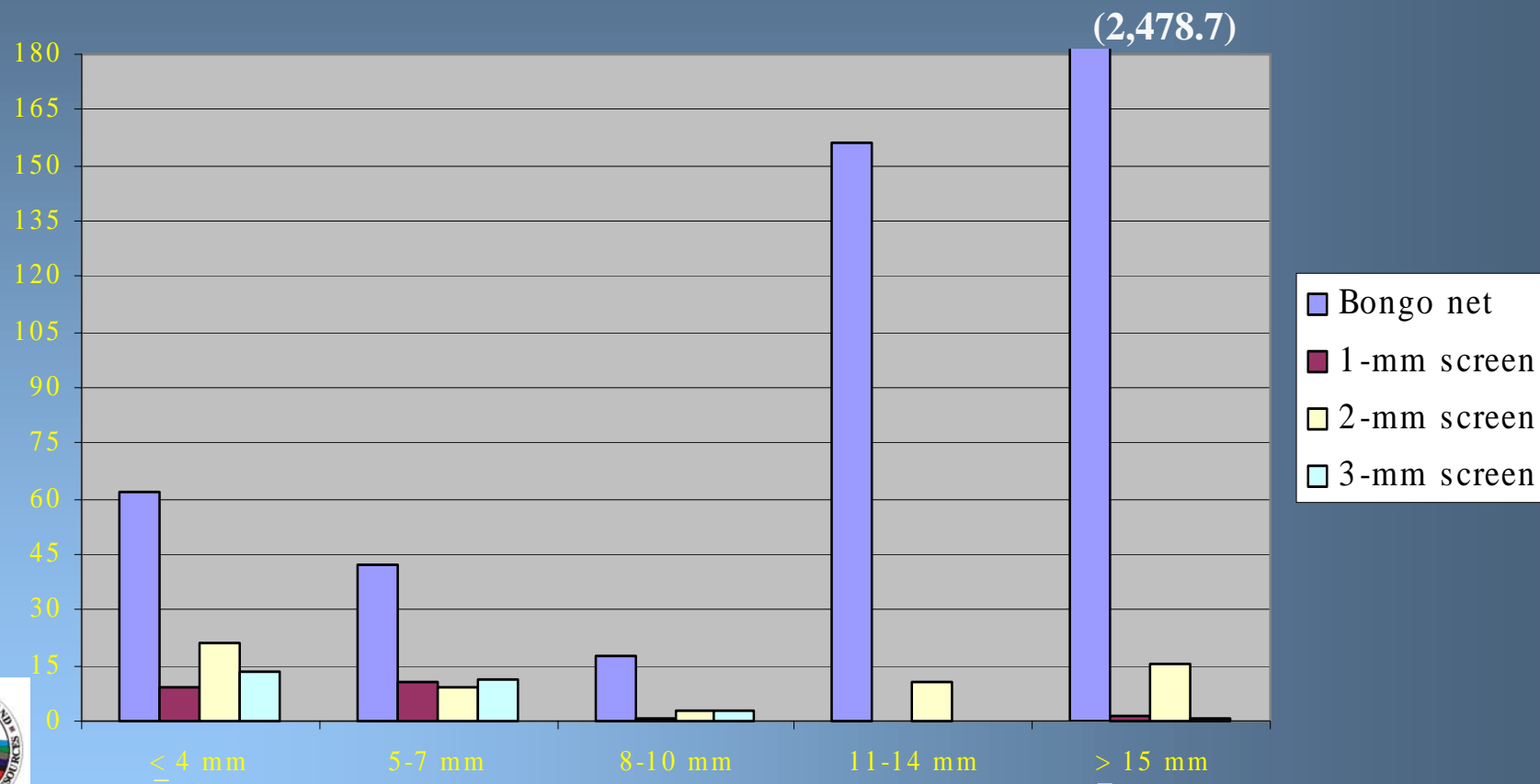


FIGURE 2.—Schematic diagram of the model intake test facility used in this study (top view).



# Densities (#/m<sup>3</sup>) of Bay Anchovy Larvae of Different Sizes



# Entrainment Issue Resolution

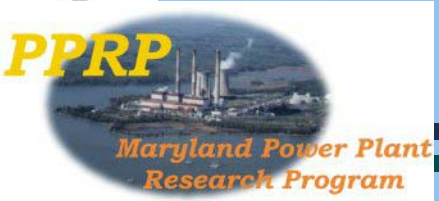
- PPRP and PEPCO modeled estimates of entrainment varied widely
- Efficacy of wedge-wire screens at the site was uncertain, but cost would be high
- Negotiated out-of-kind mitigation, involving enhancement of important resource species in the Patuxent (American shad, yellow perch, striped bass)



# Calvert Cliffs Nuclear Generating Station

- Owned by Constellation Nuclear, a member of Constellation Power Source, Inc., (formerly BGE)
- Located on Chesapeake Bay mainstem in Calvert County
- 1,675 MW
- Once-through cooling, 2.5M gpm
- Shoreline intake embayment with curtain wall and dredged intake channel







# CWIS Impact Issues at Calvert Cliffs Addressed by PPRP

- Lethality of screen wash system initially not known
- Large impingement episodes, primarily menhaden in summer/fall



# Impingement Mortality Studies

- Holding pool constructed to receive screen wash
- Provided information on immediate and delayed mortality
- Allowed benefits of different screen wash procedures to be evaluated
- Provided high quality data on impingement mortality rates
- 11 of 14 most abundant species had survival rates  $>50\%$
- 5 species had survival rates  $>90\%$
- Blue crab survival rates were 99.5%



# Survival Rates of Impinged Fish at Calvert Cliffs

Most Common Species	Percent survival
Blueback herring	47
Bay anchovy	68
Atlantic menhaden	52
Weakfish	38
Threespine stickleback	91
Skilletfish	93
Spot	84
Atlantic silverside	54
Atlantic croaker	19
Summer flounder	90
Northern searobin	50
Winter flounder	93
Northern pipefish	85
Hogchoker	99





# Royce "Smooth Tex" Screen Studies

- Smaller mesh screens installed in portion of intake
- Anticipated reduction in entrainment of smaller organisms
- Result was very high impingement rates
- Technology rejected from further consideration

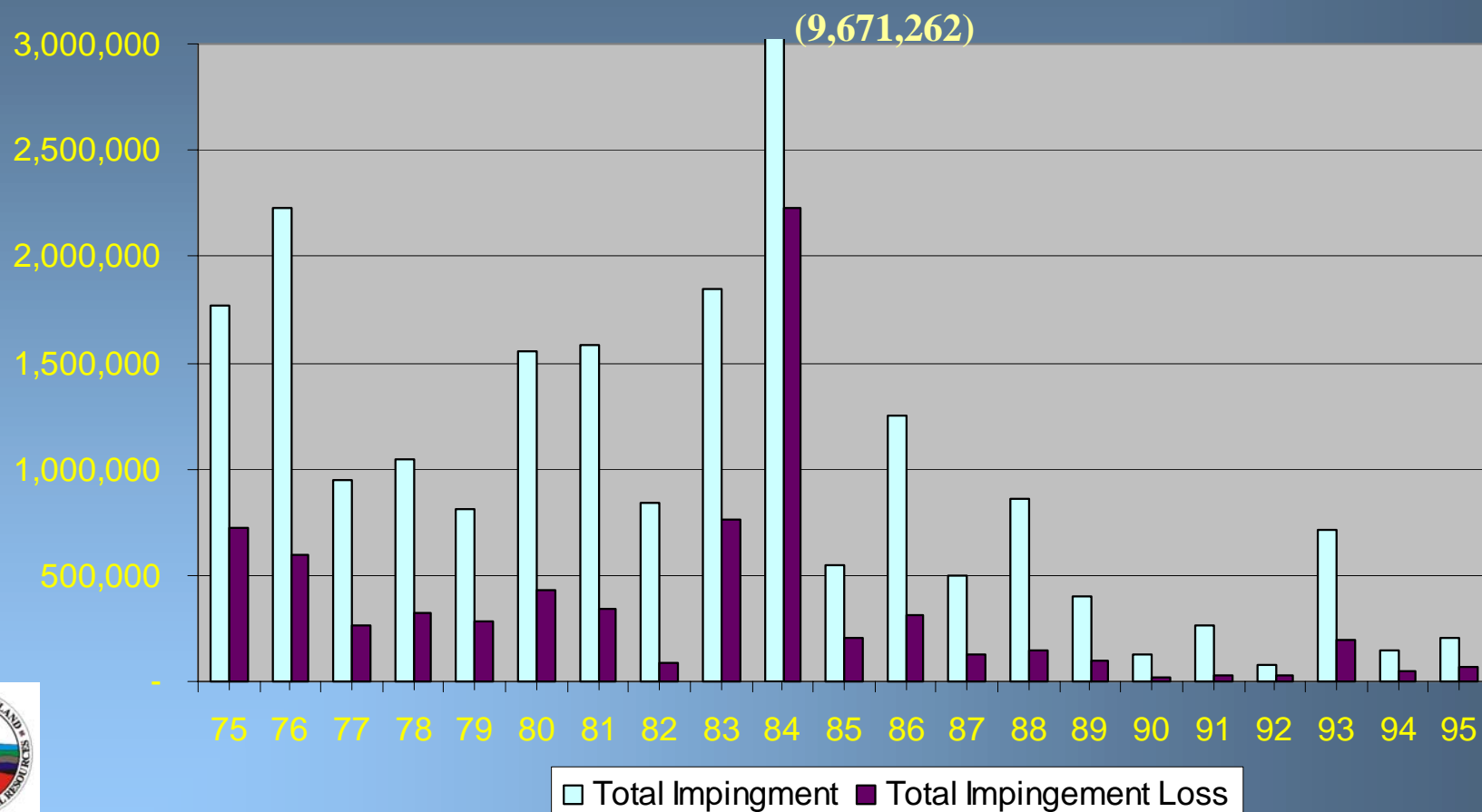


# Impingement Issue Resolution

- Studies indicated major impingement episodes were related to low DO conditions (e.g 146 thousand fish impinged in 1 hour at one unit in 1984)
- Curtain wall blocked oxygenated exit for fish concentrated in embayment
- Several curtain wall panels removed
- Eliminated major impingement episodes
- Impingement has shown major declines over time due to CWIS modifications and operational changes



# Annual Impingement at Calvert Cliffs



# Morgantown Generating Station

- Mirant Energy (formerly PEPCO)
- Located on the Potomac River in Charles County
- 1,411 MW
- Once-through cooling, 1M gpm





# CWIS Impact Issues at Morgantown Addressed by PPRP

- Screen wash discharged into discharge canal
- Impinged organisms exposed to additional thermal stress



# Impingement Issue Resolution

- Morgantown consultants identified several fish return alternatives
- PPRP negotiated redirecting of screen wash return from discharge canal into Potomac River





# Conclusions based on 30 years of PPRP Experience

- CWIS impacts can be significantly reduced by a wide variety of changes in intake structure operation, fish handling, external structure design, etc.
- Site-specific results of implementation of measures cannot be accurately predicted, so site specific studies and evaluation are critical
- Cooperative efforts between regulators and permittees are the most timely and cost-effective way of ensuring that CWIS impacts are minimized

